

Occurrence of anticancer drugs in the aquatic environment: a systematic review

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Table 1: Characteristics of the included studies

Ref	Year	Country	Compound	Sample source (n=number of samples)	Extraction	Separation and Detection	Concentration Range (ng/L)	LOD (ng/L)	LOQ (ng/L)	%R
1	1996	Germany	Ifosfamide	Hospital's main sewage pipe (n=1)	SPE – SiOH SPE cartridges	GC-MS	24	6-7	-	30-39
			Cyclophosphamide				146			
2	1996	Germany	Cyclophosphamide	Hospital's main sewage water (n=7)	SPE – SiOH SPE cartridges	GC-MS	19-4500	6	-	30
				Influent of a municipal WWTP (n=22)			<6-143 n.d. (n=1)			
				Effluent of a municipal WWTP (n=24)			6-17 n.d. (n=3)			
3	1997	Germany	Ifosfamide	Hospital of Tumour Biology effluents (n=7)	SPE – RP-18 cartridges	GC-MS	<6-1914	7	-	-
				WWTP Influent (n=12)			<6-29			
				WWTP Effluent (n=12)			<6-43			
				Countryside effluents (n=NA)			<6			
4	2001	Germany	Ifosfamide	Groundwater (n=105)	SPE – PPL Bond-Elut material	LC-ESI-MS-MS	n.d.	4.2-10	-	71-73
			Cyclophosphamide				n.d.			
5	2003	Italy	Cyclophosphamide	River (n=8)	SPE – Lichrolut EN	LC-MS-MS	n.d.	0.0074	0.022	99
6	2003	United Kingdom	Cyclophosphamide	WWTP influent and effluent (n=30)	SPE – C18	LC-MS	n.d.	23	-	89
7	2003	United Kingdom	Tamoxifen	Effluent of WWTP (n=3)	SPE – StrataX	LC-ESI-MS-MS	<10	10	-	42
				Upstream of WWTP (n=1)			<10			
				Downstream of WWTP (n=1)			<10			
8	2004	Austria	5-Fluorouracil	Hospital's wastewater (n=9)	SPE – Env+	CE - Diode array detector	20000-122000	1700	8600	87.8

9	2004	United Kingdom	Tamoxifen	Mersey estuary (n=6)	SPE – StrataX	LC-ESI-MS-MS	13 (n=1) <4 (n=5)	4	-	42
				Tyne estuary (n=6)			<4 (n=6)			
				Thames estuary (n=2)			<4 (n=2)			
				Belfast Lough estuary (n=3)			35-71 (n=2) <4 (n=1)			
				Tees estuary (n=5)			23 (n=1) <4 (n=4)			
10	2004	United Kingdom	Tamoxifen	Upstream of WWTP (n=15)	SPE – StrataX	LC-ESI-MS-MS	<10	10	-	42
				Final effluent of WWTP (n=45)			<50-42			
				Downstream of WWTP (n=15)			<10			
11	2005	United Kingdom	Tamoxifen	Raw wastewater (n=3)	SPE – StrataX	LC-ESI-MS-MS	143-215	10	-	42
				Pre-UV WW (n=3)			376-740			
				Treated WW (n=3)			146-369			
				Surface water (n=18)			27-212			
12	2005	Italy	Cyclophosphamide	Effluents of WWTPs (n=8)	SPE – LiChrolut EN and Oasis MCX	RP-LC-MS-MS	2.1 (n=1) 9.0 (n=1) n.d. (n=6)	-	0.83-1.9	76-106
			Methotrexate	Effluents of WWTPs (n=8)			12.6 (n=1) n.d. (n=7)			
13	2006	Romania	Cyclophosphamide	Somes River from 4 sites (n=4)	SPE – Oasis	GC-MS	64.8 ± 8.0	-	30	68.3
							46.1 ± 7.2			
							<30			
							<30			
14	2006	Austria	Epirubicin	Hospital effluents (n=28)	SPE – C8	RP-LC Fluorescence detection	100-1400	50-60	-	85.2-87.6
			Doxorubicin				100-500			
			Daunorubicin				n.d.			
15	2006	Austria	5-Fluorouracil	Raw WW of hospital (n=98)	SPE – StrataX and C8	CE-Diode array detection (5-FU)	<8600-124000 (untreated)	-		260-8600
			Epirubicin	Treated WW of hospital (n=NA)			<LOD (treated) n.d.			

			Doxorubicin			LC-Fluorescence detection (Anthracycline)	<260-1350 (untreated) <LOD (treated)			
			Daunorubicin				n.d.			
16	2006	Switzerland	Cyclophosphamide Ifosfamide	WWTPs influent (n=5) WWTPs effluent (n=4) Surface Water (n=5)	SPE – reusable cartridges (macroporous polystyrene divinylbenzene adsorbent)	GC-MS LC-MS-MS	(CP) 2-11 (IF) 1.4-<15 (CP) 2-10 (IF) 1.7-6 (CP) 0.05-0.17 (IF) <0.05-0.14	0.02-2	-	74-102
17	2006	Switzerland	Tamoxifen 5-Fluorouracil	Wastewaters from 1 hospital, 1 residential area, and 2 WWTPs (n=37)	LLE (TAM) SPE (5-FU) – Env+	GC-MS	(TAM) 1-4 (TAM) n.d. in treated WW (5FU) n.d.	1-30	4-90	73-81
18	2007	United Kingdom	Tamoxifen	Sewage outfall (n=NA) Upstream of sewage (n=NA) Downstream of sewage (n=NA)	SPE – Oasis HLB	LC-ESI-MS-MS	<0.003 <0.003 <0.003	0.003	0.009	49.5-62.3
19	2007	United Kingdom	Tamoxifen	Sea (n=NA) Tap water (n=NA) River (n=NA) Wastewater effluent (n=NA)	SPE – Strata X	LC-MS-MS	<0.03 <0.03 <0.03 <0.03	0.03	0.08	15-29
20	2008	Romania	Cyclophosphamide	Before upgrade of WWTP (n=3) After upgrade of WWTP (n=3)	SPE – Oasis HLB	GC-MS GC-ITMS	45-65 (n=2) <10 (n=1) n.d. (n=3)	-	10	55-110
21	2008	United Kingdom	Tamoxifen	3 WWTPs influents (n=5) 3 WWTPs effluents (n=5) Upstream WWTP (n=5) Downstream WWTP (n=5)	SPE – Oasis HLB	LC-MS-MS	0.1-1.3 0.1-0.5 n.d. n.d.	0.003	0.009	52
22	2008	Sweden	Cyclophosphamide	Influent of WWTP (n=4)	SPE – MCX and MAX	LC-MS-MS	<25	3.8-9.1	-	87-92

				Effluent of WWTP (n=4)			<15			
				Ozone-treated effluent (n=4)			<15			
				MBR treated effluent (n=4)			<20			
23	2008	Switzerland	5-Fluorouracil	Hospital WW (n=17)	SPE – Isolute Env+	HILIC-MS-MS	>5-27 (n=6)	0.00003-0.00048	5-9	-
			Gemcitabine				>0.9-38 (n=6)			
			2',2'-difluorodeoxyuridin (dFdU)				>9-840 (n=12)			
24	2009	Canada	Cyclophosphamide	Influent of WWTP (n=NA)	On-line SPE – Strata X	LC-ESI(±)-MS-MS	(CP) <5-9	5-16	14-47	55-148
			Methotrexate	Effluent of WWTP (n=NA)			(MTX) <11-59			
				River (n=NA)			(CP) <9 (MTX) <16 (CP) <9 (MTX) <16			
25	2009	Spain	Tamoxifen	SW (n=15)	SPE – Oasis HLB	LC-ESI-MS-MS	<0.3	0.3-1	1-4	66-149
				WW influent (n=3)			<1			
				WW effluent (n=3)			<0.4			
26	2009	Switzerland	5-Fluorouracil	Hospital WW (n=25)	SPE – ENV+	LC-MS-MS	<5-27	-	0.9-9	54-118
			Gemcitabine				<0.9-38			
			dFdU				<9-839			
27	2009	Australia	Cyclophosphamide	Post-reverse osmosis water (n=6)	SPE – Strata X	LC-MS-MS	(CP) <5	-	5-100	96-167
			Ifosfamide	Secondary water (n=6)			(IF) <25 (CP) <100 (IF) <100			
28	2009	France	5-Fluorouracil	Hospital effluent (n=14)	SPE – Env+	GC-MS-MS	90-4000 (n=12) n.d. (n=2)	-	-	100
29	2009	Australia	Cyclophosphamide	Hospital WW (n=4)	SPE – Oasis HLB	LC-MS-MS	<LOQ	-	100-2000	100
			Ifosfamide	WWTP influent (n=4)						
30	2009	Sweden	Cyclophosphamide	Influent WW (n=4)	Bag-SPE – XAD-2 resin	UPLC-MS-MS	Bag-SPE: 150	20	60	41.1-73.2
				Effluent WW (n=4)	SPE – Oasis HLB		SPE: 114 Bag-SPE: 114 SPE: 33.3			
31	2009	China	Vincristine		SPE – Oasis HLB		<20	2-20	-	51-105

			Azathioprine	Hospital effluents (n=65)		UPLC-ESI-MS-MS	9-32 (n=3)			
			Ifosfamide		4-10647 (n=38)					
			Cyclophosphamide		<2 (n=27)					
			Methotrexate		6-2000 (n=47)					
			Etoposide		<2 (n=18)					
			Procarbazine		4-4689 (n=14)					
			Doxorubicin		<2 (n=51)					
			Doxorubicinol		6-380 (n=15)					
				<5 (n=50)						
				<5						
				<10						
				<10						
32	2009	Canada	Cyclophosphamide Methotrexate	Drinking water (n=3)	On-line SPE – Strata X	LC-MS-MS	(CP) <1	1-2	-	61-70
				Surface water (n=3)			(MTX) <1			
							(CP) <1			
							(MTX) <2			
33	2010	China	Raloxifene (1) Letrozole (2) Anastrozole (3) Exemestane (4) Tamoxifen (5) Toremifene (6) Clomiphene (7) N-desmethyltamoxifen (8) Mifepristone (9) Finastride (10)	WWTP Influent (n=3)	SPE – Oasis HLB	LC-MS-MS	(1) 0.8-1.52 (n=3)	-	0.05-2	-
				WWTP Effluent (n=2)			(2) 0.28-0.8 (n=3)			
							(3) 0.12-0.32 (n=3)			
							(4) <MDL			
							(5) 0.28 (n=1)			
							(6) 0.58 (n=1)			
							(7) 0.18 (n=1)			
							(8) <MDL			
							(9) 0.4-1.62 (n=3)			
							(10) 0.28-1 (n=2)			
							(1) 0.26-0.4 (n=2)			
							(2) 0.27-0.6 (n=2)			
							(3) 0.3 (n=1)			
							(4) <MDL			
							(5) <MDL			
							(6) <MDL			
							(7) <MDL			
							(8) <MDL			
							(9) 0.7-0.75 (n=2)			
							(10) 0.1 (n=1)			

				Hospital effluent (n=63)			(1) 2.2-6.74 (n=2) (2) 0.2-2.38 (n=52) (3) 0.3-3.7 (n=52) (4) <MDL (5) 0.2-8.2 (n=23) (6) <MDL (7) <MDL (8) <MDL (9) 0.64-195 (n=17) (10) 0.32-4.36 (n=34)			
34	2010	Spain	Tamoxifen	Drinking Water (n=6)	On-line SPE – Hysphere Resin GP	LC-ESI-MS-MS	n.d.	0.78-5.41	2.1-18.05	74.16-88.61
				Surface Water (n=12)			n.d.			
				WW effluent (n=6)			n.d.			
35	2010	China	Methotrexate	WWTP influents and effluents (n=10)	SPE – Oasis HLB	LC-ESI-MS-MS	1.6-18.1 (influent) n.d. (effluent)	0.6-7	1.7-20	51-104
			Azathioprine				n.d.			
			Doxorubicinol				n.d.			
			Doxorubicin				n.d.			
			Cyclophosphamide				8.5-14.5			
			Ifosfamide				9.0-16.4			
			Vincristine				n.d.			
			Etoposide				n.d.			
Procarbazine	n.d.									
36	2010	Spain	Cyclophosphamide	4 WW effluents (n=5 each) 4 River water (n=5 each)	SPE – Oasis HLB	LC-MS-MS	n.d.	<5	-	81-84
			Ifosfamide				n.d.			
			Tamoxifen				n.d.			
37	2011	Canada	Cyclophosphamide Methotrexate	Raw sewage of WWTP (n=NA)	On-line SPE – Strata X	LC-APPI-MS-MS	(CP) <11 (MTX) not ionised	5-11	-	-
						LC-APCI-MS-MS	(CP) <7 (MTX) not ionised			
						LC-ESI-MS-MS	(CP) 12 (MTX) <11			
38	2011	Finland	Cyclophosphamide	WW effluent (n=1)	SPE – Oasis HLB and Strata X	UPLC-MS-MS	<26	11	26	99-110

39	2011	United Kingdom	Cyclophosphamide	WWTP 1 (Pre UV) (n=1)	SPE – Strata X	LC-ESI-MS-MS	(CP) 3.7 (IF) <0.05	0.03-0.12	0.11-0.24	-
			Ifosfamide	WWTP 1 (Post UV) (n=1)			(CP) 3.5 (IF) <0.05			
				WWTP 2 effluent (n=1)			(CP) 0.19 (IF) 0.05			
40	2011	Spain	Tamoxifen	River (n=13)	SPE – Oasis HLB	UHPLC-MS-MS	<0.05	0.02	0.05	9.3
				Tributaries (n=13)			<0.05-19.57			
41	2011	Spain	Cytarabine	(1) River water (n=3) (2) Effluent WW (n=3) (3) Influent WW (n=3)	SPE – Oasis HLB	HPLC-MS-MS	(1) 13 (2) 14 (3) 9.2	0.1-38	0.3-128	11-99
			Cyclophosphamide				(1) <1.7 (2) <2.3 (3) <2.1			
			Docetaxel				(1) <1.5 (2) <1.7 (3) <1.9			
			Doxorubicin				(1) <5.3 (2) <4.3 (3) 4.5			
			Epirubicin				(1) <3.5 (2) <0.7 (3) <3.8			
			Etoposide				(1) <2.2 (2) 3.4 (3) 15			
			5-Fluorouracil				(1) <34 (2) <21 (3) <38			
			Gemcitabine				(1) 2.4 (2) 7.0 (3) 9.3			
			Ifosfamide				(1) <1.3 (2) 1.2 (3) 3.5			
			Irinotecan				(1) <0.9 (2) <1.0 (3) <1.1			

			Methotrexate				(1) <0.1 (2) <0.1 (3) <0.1			
			Mitomycin C				(1) <2.2 (2) <2.0 (3) <1.7			
			Paclitaxel				(1) <0.3 (2) <0.2 (3) <0.3			
			Vinorelbine				(1) <4.0 (2) 9.1 (3) <5.2			
42	2012	Spain	Cyclophosphamide Epirubicin	Urban effluent (n=1) Hospital effluent (n=1) WWTP influent (n=3) WWTP effluent (n=3)	SPE – Oasis HLB	LC-MS-MS	(CP) <0.35 (Epi) <2.77-24800 (CP) 0.35-5730 (Epi) <2.77 (CP) <0.35-13100 (Epi) <2.77 (CP) <0.35 (Epi) <2.77	0.35-2.77	-	43-107
43	2012	Spain	Tamoxifen	River upstream (n=6) River downstream (n=6) WWTP effluent (n=6)	SPE – HySphere Resin GP	LC-MS-MS	<1.5 <1.5 <5.41	1.5-5.41	5.05-18	-
44	2012	Spain	Tamoxifen	River downstream WWTP (n=8) River downstream WWTP (n=3) River upstream WWTP (n=8)	SPE – Oasis HLB	LC-MS-MS	0.3-1.3 0.2-1.3 0.3-1.8	-	-	-
45	2012	Italy	Tamoxifen	Hospital effluent (n=4) Hospital effluent (n=4) Hospital effluent (n=4) WWTP influent (n=4) WWTP effluent (n=4)	SPE – Oasis HLB	LC-MS-MS	<1 <1 <2 <1 <1	1-2	-	65-145
46	2012	Spain	Tamoxifen	River (n=NA)	Online-TFC	LC-ESI-MS-MS	22.4-22.8	0.38	1.27	86.5
47	2012	Spain	Tamoxifen	River (n=9) Tributaries (n=15)	Online-TFC	LC-ESI-MS-MS	12.4-20.1 22.4-26.8	-	<10	>80

48	2012	Sweden	Flutamide	WWTPs effluents (n=6)	SPE – Oasis HLB	LC-MS-MS	<5.1	-	5.1-55	68-100
			Tamoxifen				13-24 <5 (n=1)			
			Megestrol				<55			
49	2012	Spain	Tamoxifen	Surface water (n=4)	SPE – Oasis HLB	LC-MS-MS	0.01-1.34 n.d. (n=1)	-	-	-
				Surface water (n=4)			0.16-115.04 n.d. (n=1)			
50	2012	Spain	Tamoxifen	GW (n=13)	On-line SPE – HySphere Resin GP	LC-ESI-MS-MS	9.25-88.3	0.63-1.51	2.10-5.05	74.16- 88.61
				GW (n=5)			11.2-39.3			
				GW (n=13)			18.9-223			
				River (n=1)			17.6			
51	2013	Spain	Gemcitabine	WWTP influent (n=8)	On-line SPE – PLRP-s	LC-MS-MS	<9.3	0.1-54	0.4-180	60-119
			Temozolomide				<50			
			Methotrexate				2.1-20.1			
			Irinotecan				<4.5			
			Imatinib				<180			
			Ifosfamide				7.3-43.3 (n=4) <2 (n=4)			
			Cyclophosphamide				<3			
			Erlotinib				<3.4			
			Etoposide				<65			
			Doxorubicin				<2.5			
			Capecitabine				8.2-27 (n=7) <5 (n=1)			
			Tamoxifen				3.5-17.2 (n=4) <3.4 (n=1) <1 (n=3)			
			Paclitaxel				<4.4			
			Hydroxymethotrexate				<5.2			
			Desmethylhydroxytamoxifen				<5			
Hydroxytamoxifen	<5									
Hydroxycaclitaxel	4.4 (n=1) <1.1 (n=7)									
52	2013	France Portugal	Ciprofloxacin Azathioprine	Hospital effluent 1 (n=3)	SPE – Oasis HLB	UPLC-MS-MS	CIP 679.1±21.1 AZA 21.6±2.1	0.8-24	2.4-80	46-129

		Spain	Cyclophosphamide Ifosfamide Tamoxifen Docetaxel Paclitaxel Etoposide Vincristine Methotrexate				CY 43.4±4.5 IF 31.5±7.5 TAM 59.5±3.5 DOC n.d. PAC n.d. ETO 97.5±19.1 VIN 49.1±7.2 MTX < 5.9			
				Hospital effluent 2 (n=3)			CIP 2,684.1±82.1 AZA 14.5±2 CY 35.9±5.5 IF n.d. TAM 26.3±1.1 DOC n.d. PAC n.d. ETO n.d. VIN <24.5 MTX n.d.			
				Hospital effluent 3 (n=3)			CIP 14725±2259 AZA 24.5±2.5 CY <3.6 IF n.d. TAM 94.3±2.3 DOC 97.7±21 PAC 99.7±13.1 ETO 406±68.1 VIN <24.5 MTX n.d.			
				Hospital effluent 4 (n=3)			CIP 9278.5±167 AZA 187.9±1.5 CY 200.7 ±0.9 IF 227.9±1.3 TAM 133.4±2.6 DOC n.d. PAC n.d. ETO n.d. VIN n.d. MTX n.d.			

				WW influent 1 (n=3)			CIP 1557±163.1 AZA 18.2±2.4 CY 25.5±2 IF n.d. TAM 58.3±4.7 DOC 175.1±37 PAC n.d. ETO 83±17 VIN 22.9±0.1 MTX 23±0.4			
				WW influent 2 (n=3)			CIP 1172.1±74 AZA 19.1±1.2 CY n.d. IF n.d. TAM 51±0.7 DOC n.d. PAC n.d. ETO n.d. VIN n.d. MTX <5.9			
				WW influent 3 (n=3)			CIP 3200±2.4 AZA n.d. CY n.d. IF 130.1±1.3 TAM 30±2.8 DOC n.d. PAC n.d. ETO n.d. VIN n.d. MTX n.d.			
53	2013	Slovenia	5-Fluorouracil	Hospital A effluent (n=2)	SPE – Isolute Env+	GC-MS-MS	35-92	0.16-0.48	0.54-1.6	-
			Hospital B effluent (n=2)	<0.48						
			WWTPs influent (n=2)	4.7-14						
			WWTPs effluent (n=4)	<0.16						
			Surface water (n=3)	<0.16						

54	2013	United Kingdom	Tamoxifen	WWTP influent (n=2)	SPE – Oasis HLB	LC-MS-MS	16-46	0.003	0.009	49.5-62.3
				WWTP effluent (n=2)			8-32			
55	2013	France	Cyclophosphamide Ifosfamide	Surface water (n=7)	On-line SPE – Strata X	LC-MS-MS	n.d.	4	11	88.7-110
				Tap water (n=2)			n.d. n.d.			
56	2014	Canada	Gemcitabine Methotrexate Ifosfamide Cyclophosphamide Irinotecan Epirubicin	WWTPs influent (n=4)	On-line SPE – Hypersil Gold PFP	LC-MS-MS	(GCA) <20 (MTX) 17-60 (IF) <4 (CP) 17-22 (n=2) (CPT-11) <6 (EPI) <18	4-20	13-60	47-90
				WWTPs effluent (n=5)			(GCA) <20 (MTX) 13-53 (n=4) (IF) <4 (CP) 18-21 (n=2) (CPT-11) <6 (EPI) <18			
57	2014	Spain	(1)Cyclophosphamide (2)Cytarabine (3)Docetaxel (4)Doxorubicin (5)Epirubicin (6)Etoposide (7)5-Fluorouracil (8)Gemcitabine (9)Ifosfamide (10)Irinotecan (11)Methotrexate (12)Mitomycin C (13)Paclitaxel (14)Vinorelbine	Influent WW (n=48)	SPE – Oasis HLB	LC-MS-MS	(1) <2.13 (2) 44.4-464 (3) <1.89 (4) <4.15 (5) <3.75 (6) 15.1-46.8 (7) <38.4 (8) 39.3-52.1 (9) 6.49-19.1 (10) <1.12 (11) 7.30-55.8 (12) <1.66 (13) <0.26 (14) <5.18	0.08-38.4	0.27-128	11-105

				Effluent WW (n=48)			(1) <2.29 (2) 9.9-190 (3) <1.65 (4) 20.3-42.4 (5) <0.7 (6) <2.95 (7) <21.1 (8) 64.6-88.4 (9) 4.14-15.6 (10) <1.04 (11) <0.08 (12) <1.97 (13) 1.4-2.19 (14) 44.1-170			
⁵⁸	2014	Spain	Tamoxifen	River (n=549)	SPE – Strata X	LC-ESI-MS-MS	3.5-11.7 (n=6)	2	3	75
⁵⁹	2014	Spain	(1)Cyclophosphamide (2)Ifosfamide (3)Capecitabine (4)Epirubicin (5)Irinotecan (6)Goserelin (7)Megestrol (8)Prednisone	Hospital A effluent (n=20)	SPE – Oasis HLB	LC-MS-MS	(1) <4-4720 (2) <6-86200 (3) 15-490 (4) <45 (5) <4-730 (6) <16-350 (7) <3-1260 (8) <12-210	-	3-45	44-104
				WWTP influent (n=5)			(1) <4-10 (2) <6 (3) <15 (4) <45 (5) <4 (6) <16 (7) <3-150 (8) <12			
				WWTP effluent (n=5)			(1) <4-5 (2) n.d. (3) n.d. (4) n.d. (5) n.d. (6) n.d. (7) <3-20			

							(8) n.d.			
				Hospital B effluent (n=10)			(1) <4-20 (2) <6-2690 (3) <15 (4) <45-60 (5) <4 (6) <16 (7) <3-70 (8) <12			
				WWTP influent (n=10)			(1) <4 (2) <6 (3) <15 (4) <45 (5) <4 (6) <16 (7) <3-220 (8) <12			
				WWTP effluent (n=10)			(1) n.d. (2) n.d. (3) n.d. (4) n.d. (5) n.d. (6) n.d. (7) <3 (8) n.d.			
60	2014	Spain	(1)Azathioprine (2)Ciprofloxacin (3)Cyclophosphamide (4)Docetaxel (5)Etoposide (6)Ifosfamide (7)Methotrexate (8)Paclitaxel (9)Tamoxifen (10)Vincristine	Hospital WW (n=3)	SPE – Oasis HLB	UPLC-MS-MS	(1) <12.7-90 (2) 3089-14826 (3) <3.6-43 (4) 61-79 (n=2) (5) <80-714 (6) n.d. (7) 6-19 (n=2) (8) <18.4-100 (9) 36-170 (10) <24.5 (n=1)	0.2-28.8	0.8-96.2	56.5-129.7
				WW influent (n=3)			(1) 19-20 (n=2) (2) 1172-1558 (3) 8-26			

							(4) 65-219 (5) <96.2 (n=2) (6) n.d. (7) <4.8 -23 (8) 18 (n=1) (9) 15-58 (10) n.d.			
				WW effluent (n=3)			(1) n.d. (2) 36-147 (3) 7-25 (4) n.d. (5) n.d. (6) n.d. (7) 6 (n=1) (8) <8.7 (n=1) (9) 11-42 (10) n.d.			
				SW before WWTP (n=3)			(1) n.d. (2) 8-56 (3) n.d. (4) n.d. (5) n.d. (6) n.d. (7) n.d. (8) n.d. (9) 12-36 (10) n.d.			
				SW after WWTP (n=3)			(1) n.d. (2) 7-103 (3) <0.9-20 (4) n.d. (5) n.d. (6) n.d. (7) 5 (n=1) (8) n.d. (9) 25-38 (10) n.d.			

61	2014	Spain	Methotrexate Ifosfamide Cyclophosphamide Irinotecan Doxorubicin Capecitabine Tamoxifen Endoxifen Hydroxytamoxifen Hydroxyapatitaxel	WW influent (n=24)	On-line SPE – PLRP-s cartridges	LC-MS-MS	MET 2.6-18.1 (n=6) IF 2.2-27.9 (n=9) CP 2.4-43.8 (n=12) IRI 8.8-21.3 (n=4) DOX 2.5-2.7 (n=2) CAP 5.6-72.6 (n=11) TAM 177.6-180.6 (n=4) OH-D-TAM <LOD OH-TAM <LOD OH-PAC 3.7-18.5 (n=4)	-	1.1-4.5	71-119
				WW effluent (n=31)			MET 2-19.4 (n=4) IF 2.5-19.4 (n=12) CP 2.5-100 (n=20) IRI 16.8 (n=1) DOX <LOD TAM 102-147 (n=12) OH-D-TAM 91.6 (n=1) OH-TAM 5.8-164 (n=3) OH-PAC 3.7 (n=1)			
62	2015	Slovenia	Cyclophosphamide Ifosfamide	Hospital WW (n=10)	SPE – Oasis HLB	GC-MS	CP 15-22000 (n=7) IF 48-6800 (n=3)	0.36-2.8	1.2-9.4	93-99
				WWTP influent (n=4)			CP 19-27 (n=2) IF n.d.			
				WWTP effluent (n=4)			CP 17 (n=1) IF n.d.			
63	2015	Spain	Cisplatin	Hospital WW (n=1)	-	ZIC-HILIC-ICP- MS	14.4	0.1726	0.5753	95-101
				WWTP influent (n=1)			7.9			
				WWTP effluent (n=1)			5.9			
	Slovenia	Cisplatin	Hospital WW (n=1)	-	ZIC-HILIC-ICP- MS	352				
			WWTP influent (n=1)			23.3				
			WWTP effluent (n=1)			12.8				

64	2015	Japan	(1)Bicultamide (2)Capecitabine (3)Cyclophosphamide (4)Doxifluridine (5)Tamoxifen (6)Tegafur	River main stream (n=24)	SPE – Oasis Max	UPLC-MS-MS	(1) 32 (2) 2 (3) 2 (4) n.d. (5) n.d. (6) n.d.	0.1-0.2	0.2-0.8	63-124
				Tributary (n=16)			(1) 30 (2) 1 (3) 3 (4) n.d. (5) n.d. (6) n.d.			
				WWTP effluent (n=10)			(1) 245 (2) 6 (3) 10 (4) n.d. (5) n.d. (6) 23			
				WWTP effluent ozonation (n=10)			(1) 5 (2) 2 (3) 3 (4) n.d. (5) n.d. (6) n.d.			
65	2015	United Kingdom	(1)Ifosfamide (2)3-N-Dechloroethyl ifosfamide	WW effluent (n=NA)	SPE – Oasis HLB - MAX	cLC-MS-MS	(1) <0.31 E1 (1) <0.29 E2 (2) <11.1 E1 (2) <9.79 E2	0.04-3.33	0.14-11.10	1.5-119.2
				Surface water (n=NA)			(1) <0.14 E1 (1) <0.15 E2 (2) <3.62 E1 (2) <3.78 E2			
66	2016	United Kingdom	Azathioprine Methotrexate Ifosfamide Tamoxifen	WW influent (n=3)	SPE – Oasis HLB	UPLC-MS-MS	<1.36 <23.45 <1.53 <3.5	0.08-14.52	0.4-72.6	66.4-114.1
				WW effluent (n=3)			<1.2 <29.83			

							<1.22 <3.82			
				Surface water (n=3)			<0.55 <20.24 <0.4 <72.6			
67	2016	Slovenia	(1)Cyclophosphamide (2)Ifosfamide (3)Carboxy-CP (4)Keto-CP (5)N-decl-CP	Hospital WW (n=7)	SPE – Oasis HLB and Env+	GC-MS	(1) 76-2686 (2) 26-47 (3) 213-13202 (4) <13.1-178 (5) 60-2099	2-23	6.7-77.7	58.1-102.9
				WWTP influent (n=1)			n.d.			
				WWTP effluent (n=1)			n.d.			
68	2016	Northern and Central Europe	(1)Ifosfamide (2)3-N-Dechloroethyl ifosfamide	WWTP influent (n=6)	SPE – Oasis HLB - Max	cUHPSFC-MS- MS	(1) <0.51 E1 (1) <0.58 E2 (2) <0.46 E1 (2) <0.22 E2	0.51-8.62	1.54-28.7	>70
				WWTP effluent (n=6)			(1) <0.51 E1 (1) <0.54 E2 (2) <1.35 E1 (2) <8.62 E2			
69	2016	Slovenia	(1)Platinum (2)Cyclophosphamide (CP) (3)Ifosfamide (4)Keto-cyclophosphamide (5)N-dechloroethyl-CP (6)Carboxy-CP (7)5-Fluorouracil (8)Gemcitabine (9)Methotrexate (10)Hydroxymethotrexate (11)Irinotecan (12)Erlotinib (13)Capecitabine (14)Endoxifen (15)(Z)-4- hydroxytamoxifen	Hospital WW (n=2)	On-line SPE SPE – Oasis HLB, Isolute Env+ and PLRP-s crosslinked styrene- divinylbenzene polymer	GC-MS ICP-MS LC-MS-MS	(1) 226-352 (2) 1080-22100 (3) <4.8-48 (4) 270-1340 (5) 847-5520 (6) 17700-60600 (7) <1.6-6.9 (8) <0.7 (9) 19-3920 (10) <1.6-490 (11) <1.4-9.2 (12) 2-4 (13) <0.7-106 (14) <1.5 (15) <5-10 (16) <3.4-10	0.3-54	1.1-180	-

		(16) Tamoxifen	WWTP influent (n=2)	(1) 23-27 (2) 19-27 (3) <4.8 (4) <13 (5) <2 (6) <23 (7) <0.5-3.1 (8) <0.7-61 (9) 29-303 (10) <1.6-366 (11) <1.4-49 (12) 3.5-8.1 (13) <0.7-158 (14) <1.5-66 (15) <5-35 (16) 11-61
			WWTP effluent (n=1)	(1) <2 (2) 17 (3) <4.8 (4) <13 (5) <2 (6) <23 (7) <0.5 (8) <0.7 (9) <0.5 (10) <1.3 (11) <0.4 (12) 3.8 (13) <0.4 (14) <1.5 (15) <0.3 (16) 7.1
			Hospital WW (n=2)	(1) <2 (2) <2.3-32 (3) <4.8 (4) <13 (5) <2 (6) <23 (7) <0.5-2.1
	Spain			

							(8) <0.7 (9) <0.6-29 (10) <1.6 (11) <1.4 (12) 2.4-5.5 (13) <0.7 (14) <1.5-11 (15) <0.7-<5 (16) <1-7.9			
				WWTP influent (n=2)			(1) <2 (2) <2.3-6 (3) <4.8 (4) <13 (5) <2 (6) <23 (7) <1.6-3.5 (8) <0.7 (9) 8.3-29 (10) <1.6 (11) <1.4 (12) 6.1-7.2 (13) <0.7 (14) <1.5-75 (15) <5-7.7 (16) 6.7-15			
				WWTP effluent (n=1)			(1) <2 (2) <2.3 (3) <4.8 (4) <13 (5) <2 (6) <23 (7) <1.6 (8) <0.7 (9) <0.5 (10) <1.3 (11) <0.4 (12) 3.3 (13) <0.5 (14) 14			

							(15) <1.1 (16) <0.9			
70	2016	Poland	Cyclophosphamide Ifosfamide	WW influent (n=41)	SPE – Oasis HLB	LC-MS-MS	(CP) 9.3-33.3 (IF) 10.1-27.3	0.12-3.06	0.36-9.19	57.5-87.1
				WW effluent (n=42)			(CP) 1-24 (IF) 2.2-28			
				Untreated water (n=42)			(CP) 2.6-3.6 (IF) <0.18			
				Treated water (n=42)			(CP) <0.12 (IF) <0.12			
71	2017	United Kingdom	(1)Ifosfamide (2)3-N-Dechloroethylifosfamide	WW influent (n=3)	SPE – Oasis HLB - MAX	cLC-MS-MS	(1) <0.24 E1 (1) <0.28 E2 (2) <5	0.12-5	0.41-16.7	88.5-113.4
				WW effluent (n=3)			(1) <0.23 E1 (1) <0.22 E2 (2) <5			
				River (n=3)			(1) <0.12 E1 (1) <0.13 E2 (2) <1.06			
72	2017	Spain	(1)Cyclophosphamide (2)Mycophenolic acid (3)Prednisone (4)Capecitabine	WWTP influent (n=4)	SPE – Oasis HLB	UPLC-MS-MS	(1) 15 (2) 3099 (3) 261 (4) 81	2.5-120	-	57-134
				WWTP effluent (n=4)			(1) 17 (2) 195 (3) n.d. (4) 13			
				WWTP effluent (n=4)	MCPS		(1) 19 (2) 136 (3) n.d. (4) n.d.			
73	2017	Japan	Cyclophosphamide Ifosfamide	WWTP influent (n=1)	SPE – Sep Pak PS2 and AC2	LC-MS-MS	n.d.	8	-	73.7-100.4
				WWTP effluent (n=1)			n.d. n.d.			
74	2017	Spain	Cyclophosphamide	2 Hospitals effluents (n=10)	On-line SPE – PLRP-s cartridges	LC-MS-MS	46-3000	0.06-22	0.3-75	-
			Ifosfamide				<0.2-4761			
			Temozolomide				<0.7)			

			Methotrexate				<0.1-4756			
			Hydroxymethotrexate				<0.2-846			
			Gemcitabine				<0.3			
			Capecitabine				<0.2-1749			
			Doxorubicin				<0.1			
			Irinotecan				<0.1-273			
			Etoposide				<3			
			Imatinib mesilate				<22-577			
			Erlotinib				<0.1			
			Paclitaxel				<0.6			
			6(α)-Hydroxypaclitaxel				<0.4			
			Tamoxifen citrate				<0.3			
			Endoxifen				<0.3			
			(Z)-4-Hydroxytamoxifen				<0.06			
75	2018	Spain	Methotrexate	WW influent (n=1)	SPE – Oasis HLB	UPLC-MS-MS	n.d.	0.00002	0.07	72
			WW effluent (n=1)	n.d.						
			Coastal water (n=28)	n.d.-3.5						
			Oceanic water (n=13)	n.d.						

E1-E2: enantiomer 1 and 2

LOD: limit of detection

LOQ: limit of quantification

%R : recovery percentage

n.d: not detected

n: number of samples

NA: not available

GW: groundwater

SW: surface water

WW: wastewater

WWTP: wastewater treatment plant

cLC: chiral liquid chromatography

cUHPSFC: chiral ultra high performance supercritical fluid chromatography

MCPS: macroporous ceramic passive sampler

Table 2: Sampling methods of the four most frequently studied compounds

Compound	Sampling type	Sampling location	Number of samples	Ref
CP	Composite sample (24h)	Hospital effluent	1	1
	Composite sample (24h)	Hospital effluent	7	2
	Sampling period of 1 h	Influent WWTP	22	2
	Sampling period of 1 h	Effluent WWTP	24	2
	NA	Groundwater	105	4
	Grab sample	River	8	5
	Time weighted composites	Sewage influent and effluent	30	6
	Composite sample (24h)	Effluent WWTP	8	12
	Grab sample	River	4	13
	Flow proportional (24h)	Influent WWTP	5	16
	Flow proportional (24h)	Effluent WWTP	4	16
	Grab sample	Surface water	5	16
	Grab sample	River	6	20
	Composite sample (24h)	Influent Wastewater	4	22
	Composite sample (24h)	Effluent Wastewater	12	22
	Grab sample	Influent WWTP	NA	24
	Grab sample	Effluent WWTP	NA	24
	Grab sample	River	NA	24
	Grab and composite samples	Treated wastewater	12	27
	Composite samples	Hospital effluent	4	29
	Composite samples	WWTP influent	4	29
	Composite samples (24h)	Influent WW	4	30
	Composite samples (24h)	Effluent WW	4	30
	Grab samples	Hospital effluent	65	31
	Grab samples	Drinking water	3	32
	Grab samples	Surface water	3	32
	Composite samples (24h)	Influent and effluent WWTP	10	35
	Composite samples (24h)	Effluent WWTP	20	36
	Grab samples	River	20	36
	NA	Raw sewage of WWTP	NA	37
	NA	Effluent WW	1	38
	NA	Effluent WWTP	3	39
	Composite sample (24h)	Influent WWTP	3	41
	Composite sample (24h)	Effluent WWTP	3	41
	Grab sample	River	3	41
	Composite sample (24h)	Influent WWTP	3	42
	Composite sample (24h)	Effluent WWTP	3	42
	Composite sample (24h)	Urban effluent	1	42
	Composite sample (24h)	Hospital effluent	1	42
	Time-proportional sampling	Raw wastewater	8	51
NA	Hospital effluent	3	52	
NA	Influent WW	3	52	
NA	River	7	55	
NA	Tap water	2	55	

	NA	Influent WWTP	4	56
	NA	Effluent WWTP	5	56
	Composite sample (24h)	Influent WW	48	57
	Composite sample (24h)	Effluent WW	48	57
	Composite sample (24h)	Hospital effluent	30	59
	Composite sample (24h)	Influent WWTP	15	59
	Composite sample (24h)	Effluent WWTP	15	59
	NA	Hospital effluent	3	60
	NA	Influent WWTP	3	60
	NA	Effluent WWTP	3	60
	NA	Surface water	6	60
	Composite sample (24h)	Influent WW	24	61
	Composite sample (24h)	Effluent WW	31	61
	Composite sample (24h) & Grab sample	Hospital effluent	10	62
	Composite sample (24h) & Grab sample	Influent WWTP	4	62
	Composite sample (24h) & Grab sample	Effluent WWTP	4	62
	Grab sample	River	40	64
	Grab sample	Effluent WWTP	20	64
	Grab sample	Hospital effluent	7	67
	Composite sample (24h)	Influent WWTP	1	67
	Composite sample (24h)	Effluent WWTP	1	67
	Grab sample	Hospital WW	4	69
	Composite sample (24h)	Influent WWTP	4	69
	Composite sample (24h)	Effluent WWTP	2	69
	Grab sample	Influent WWTP	41	70
	Grab sample	Effluent WWTP	42	70
	Grab sample	Untreated water	42	70
	Grab sample	Treated water	42	70
	Grab sample	Influent WWTP	4	72
	Grab sample	Effluent WWTP	7	72
	Grab sample	Influent WWTP	1	73
	Grab sample	Effluent WWTP	1	73
	Composite sample	Hospital effluents	10	74
IF	Composite sample (24h)	Hospital effluent	1	1
	NA	Hospital effluent	7	3
	Sampling period of 1-2h	Influent WWTP	12	3
	Sampling period of 1-2h	Effluent WWTP	12	3
	NA	Groundwater	105	4
	Flow proportional (24h)	Influent WWTP	5	16
	Flow proportional (24h)	Effluent WWTP	4	16
	Grab sample	Surface water	5	16
	Grab and composite samples	Treated wastewater	12	27
	Composite samples	Hospital effluent	4	29
	Composite samples	WWTP influent	4	29
	Grab samples	Hospital effluent	65	31
	Composite samples (24h)	Influent and effluent WWTP	10	35

Composite samples (24h)	Effluent WWTP	20	36
Grab samples	River	20	36
NA	Effluent WWTP	3	39
Composite sample (24h)	Influent WWTP	3	41
Composite sample (24h)	Effluent WWTP	3	41
Grab sample	River	3	41
Time-proportional sampling	Raw wastewater	8	51
NA	Hospital effluent	3	52
NA	Influent WW	3	52
NA	River	7	55
NA	Tap water	2	55
NA	Influent WWTP	4	56
NA	Effluent WWTP	5	56
Composite sample (24h)	Influent WW	48	57
Composite sample (24h)	Effluent WW	48	57
Composite sample (24h)	Hospital effluent	30	59
Composite sample (24h)	Influent WWTP	15	59
Composite sample (24h)	Effluent WWTP	15	59
NA	Hospital effluent	3	60
NA	Influent WWTP	3	60
NA	Effluent WWTP	3	60
NA	Surface water	6	60
Composite sample (24h)	Influent WW	24	61
Composite sample (24h)	Effluent WW	31	61
Composite sample (24h) & Grab sample	Hospital effluent	10	62
Composite sample (24h) & Grab sample	Influent WWTP	4	62
Composite sample (24h) & Grab sample	Effluent WWTP	4	62
NA	River	NA	65
NA	Effluent WWTP	NA	65
Grab sample	Influent WW	3	66
Grab sample	Effluent WW	3	66
Grab sample	River	3	66
Grab sample	Hospital effluent	7	67
Composite sample (24h)	Influent WWTP	1	67
Composite sample (24h)	Effluent WWTP	1	67
Composite sample (24h)	Influent WWTP	6	68
Composite sample (24h)	Effluent WWTP	6	68
Grab sample	Hospital WW	4	69
Composite sample (24h)	Influent WWTP	4	69
Composite sample (24h)	Effluent WWTP	2	69
Grab sample	Influent WWTP	41	70
Grab sample	Effluent WWTP	42	70
Grab sample	Untreated water	42	70
Grab sample	Treated water	42	70
Composite sample (24h)	Influent WW	3	71
Composite sample (24h)	Effluent WW	3	71
Grab sample	River	3	71

	Composite sample	Hospital effluents	10	74
MTX	Composite sample (24h)	Effluent WWTP	8	12
	Grab sample	Influent WWTP	NA	24
	Grab sample	Effluent WWTP	NA	24
	Grab sample	River	NA	24
	Grab samples	Hospital effluent	65	31
	Grab samples	Drinking water	3	32
	Grab samples	Surface water	3	32
	Composite samples (24h)	Influent and effluent WWTP	10	35
	NA	Raw sewage of WWTP	NA	37
	Composite sample (24h)	Influent WWTP	3	41
	Composite sample (24h)	Effluent WWTP	3	41
	Grab sample	River	3	41
	Time-proportional sampling	Raw wastewater	8	51
	NA	Hospital effluent	3	52
	NA	Influent WW	3	52
	NA	Influent WWTP	4	56
	NA	Effluent WWTP	5	56
	Composite sample (24h)	Influent WW	48	57
	Composite sample (24h)	Effluent WW	48	57
	NA	Hospital effluent	3	60
	NA	Influent WWTP	3	60
	NA	Effluent WWTP	3	60
	NA	Surface water	6	60
	Composite sample (24h)	Influent WW	24	61
	Composite sample (24h)	Effluent WW	31	61
	Grab sample	Influent WW	3	66
	Grab sample	Effluent WW	3	66
	Grab sample	River	3	66
	Grab sample	Hospital WW	4	69
	Composite sample (24h)	Influent WWTP	4	69
	Composite sample (24h)	Effluent WWTP	2	69
	Composite sample	Hospital effluents	10	74
	Composite sample (24h)	Influent WWTP	1	75
Composite sample (24h)	Effluent WWTP	1	75	
Grab sample	Coastal water	28	75	
Grab sample	Oceanic water	13	75	
TAM	Grab sample	Effluent WWTP	3	7
	Grab sample	Surface water	2	7
	Grab sample	River	22	9
	Hourly interval	Effluent WWTP	45	10
	Hourly interval	River	30	10
	Composite sample (12h)	WTW samples	9	11
	Grab sample (*3)	Surface water	18	11
	Composite sample (24h)	Wastewater	37	17
	NA	River	NA	18
	NA	Effluent WW	NA	19
NA	Tap water	NA	19	

NA	River	NA	19
NA	Sea	NA	19
NA	Influent WWTP	5	21
NA	Effluent WWTP	5	21
NA	River	10	21
NA	Influent WWTP	3	25
NA	Effluent WWTP	3	25
NA	River	15	25
Composite sampling (24h)	Influent WWTP	3	33
Composite sampling (24h)	Effluent WWTP	2	33
Composite sampling (2days)	Hospital effluent	63	33
Grab samples	Drinking water	6	34
Grab samples	River	12	34
Grab samples	Effluent WWTP	6	34
Composite samples (24h)	Effluent WWTP	20	36
Grab samples	River	20	36
NA	River	26	40
Grab sample	River	12	43
Grab sample	Effluent WWTP	6	43
Composite sample (different depths)	River	30	44
Composite sample (24h)	Hospital effluent	12	45
Composite sample (24h)	Influent WWTP	4	45
Composite sample (24h)	Effluent WWTP	4	45
NA	River	NA	46
Grab sample	River	24	47
Composite sample (24h)	Effluent WWTP	6	48
Composite sample	River	8	49
Grab sample	Groundwater	31	50
Grab sample	River	1	50
Time-proportional sampling	Raw wastewater	8	51
NA	Hospital effluent	3	52
NA	Influent WW	3	52
Grab sample	Influent WWTP	2	54
Grab sample	Effluent WWTP	2	54
Grab sample	River	549	58
NA	Hospital effluent	3	60
NA	Influent WWTP	3	60
NA	Effluent WWTP	3	60
NA	Surface water	6	60
Composite sample (24h)	Influent WW	24	61
Composite sample (24h)	Effluent WW	31	61
Grab sample	River	40	64
Grab sample	Effluent WWTP	20	64
Grab sample	Influent WW	3	66
Grab sample	Effluent WW	3	66
Grab sample	River	3	66
Grab sample	Hospital WW	4	69
Composite sample (24h)	Influent WWTP	4	69
Composite sample (24h)	Effluent WWTP	2	69

Table 3: Extraction and determination techniques of the four most frequently studied compounds

Compound	Extraction	Separation and detection	Concentration range in ng/L	Ref
CP	SPE: C18	GC-EI-MS	146	1
	SPE: C18	GC-EI-MS	6-4500	2
	SPE: PPL Bond-Elut	LC-ESI-MS-MS	n.d.	4
	SPE: LiChrolutEN	LC-ESI-MS-MS	n.d.	5
	SPE: C18	LC-ESI-MS-MS	n.d.	6
	SPE: Lichrolut EN	LC-ESI-MS-MS	2.1-9	12
	SPE: Oasis	GC-EI-MS	<30-64.8	13
	SPE: macroporous polystyrene divinylbenzene adsorbent	LC-ESI-MS-MS	0.05-0.17	16
	SPE: macroporous polystyrene divinylbenzene adsorbent	GC-MS	2-11	16
	SPE: Oasis HLB	GC-EI-MS	45-65	20
	SPE: Oasis HLB	GC-EI-ITMS	n.d.	20
	SPE: MCX/MAX	LC-ESI-MS-MS	<25	22
	On-line SPE: Strata-X	LC-ESI-MS-MS	<5-9	24
	SPE: Strata-X	LC-ESI-MS-MS	<5	27
	SPE: Oasis HLB	LC-ESI-MS-MS	<100-<2000	29
	SPE: Oasis HLB	UPLC-QToF-MS-MS	33.3-114	30
	Bag-SPE: XAD-2	UPLC-QToF-MS-MS	114-150	30
	SPE: Oasis HLB	UPLC-ESI-MS-MS	4-2000	31
	On-line SPE: Strata-X	LC-ESI-MS-MS	<1	32
	SPE: Oasis HLB	LC-ESI-MS-MS	8.5-14.5	35
	SPE: Oasis HLB	LC-ESI-MS-MS	n.d.	36
	On-line SPE: Strata-X	LC-APPI-MS-MS	<11	37
	On-line SPE: Strata-X	LC-APCI-MS-MS	<7	37
	On-line SPE: Strata-X	LC-ESI-MS-MS	12	37
	SPE: Oasis MCX & Strata-X	UPLC-ESI-MS-MS	<26	38
	SPE: Strata-X & Florisil	LC-ESI-MS-MS	0.19-3.7	39
	SPE: Oasis HLB	LC-ESI-MS-MS	<1.7-<2.3	41
	SPE: Oasis HLB	LC-ESI-MS-MS	5730-13100	42
	On-line SPE: PLRP-s	LC-ESI-MS-MS	n.d.	51
	SPE: Oasis HLB	UPLC-ESI-MS-MS	25.5-200.7	52
	On-line SPE: Strata-X	LC-ESI-MS-MS	n.d.	55
	On-line SPE: Hypersil Gold PFP	LC-ESI-MS-MS	17-22	56
	SPE: Oasis HLB	LC-ESI-MS-MS	<2.13-<2.29	57
	SPE: Oasis HLB	LC-HESI-MS-MS	5-4720	59
	SPE: Oasis HLB	UPLC-ESI-MS-MS	7-43	60
	On-line SPE: PLRP-s	LC-ESI-MS-MS	2.4-100	61
	SPE: Oasis HLB	GC-EI-MS	15-22000	62
	SPE: Oasis MAX	LC-ESI-MS-MS	16-22	64
	SPE: Oasis HLB	GC-EI-MS	76-2686	67
	SPE: Oasis HLB	GC-EI-MS	6-22100	69
SPE: Oasis HLB	LC-ESI-MS-MS	1-33.3	70	
SPE: Oasis HLB	LC-ESI-MS-MS	15-17	72	
MCPS	LC-ESI-MS-MS	19	72	
SPE: PS2/AC2, HLB/AC2, PLS-3/AC2	LC-ESI-MS-MS	n.d.	73	
On-line SPE: PLRP-s	LC-ESI-MS-MS	46-3000	74	
IF	SPE: C18	GC-EI-MS	24	1
	SPE: RP-18	GC-EI-MS	<6-1914	3
	SPE: PPL Bond-Elut	LC-ESI-MS-MS	n.d.	4

	SPE: macroporous polystyrene divinylbenzene adsorbent	LC-ESI-MS-MS	<0.05-0.14	16
	SPE: macroporous polystyrene divinylbenzene adsorbent	GC-MS	1.4-<15	16
	SPE: Strata-X	LC-ESI-MS-MS	<25	27
	SPE: Oasis HLB	LC-ESI-MS-MS	<100-<2000	29
	SPE: Oasis HLB	UPLC-ESI-MS-MS	4-10647	31
	SPE: Oasis HLB	LC-ESI-MS-MS	9-16.4	35
	SPE: Oasis HLB	LC-ESI-MS-MS	n.d.	36
	SPE: Strata-X & Florisil	LC-ESI-MS-MS	n.d.	39
	SPE: Oasis HLB	LC-ESI-MS-MS	1.2-3.5	41
	On-line SPE: PLRP-s	LC-ESI-MS-MS	7.3-43.3	51
	SPE: Oasis HLB	UPLC-ESI-MS-MS	31.5-227.9	52
	On-line SPE: Strata-X	LC-ESI-MS-MS	n.d.	55
	On-line SPE: Hypersil Gold PFP	LC-ESI-MS-MS	<4	56
	SPE: Oasis HLB	LC-ESI-MS-MS	4.14-19.1	57
	SPE: Oasis HLB	LC-HESI-MS-MS	2690-86200	59
	SPE: Oasis HLB	UPLC-ESI-MS-MS	n.d.	60
	On-line SPE: PLRP-s	LC-ESI-MS-MS	2.2-27.9	61
	SPE: Oasis HLB	GC-EI-MS	48-6800	62
	SPE: Oasis HLB-MAX	cHPLC-ESI-MS-MS	<0.14-<0.31	65
	SPE: Oasis HLB	UPLC-ESI-MS-MS	<0.4-<1.53	66
	SPE: Oasis HLB	GC-EI-MS	26-47	67
	SPE: Oasis HLB-MAX	UHPSFC-ESI-MS-MS	<0.51-<0.58	68
	SPE: Oasis HLB	GC-EI-MS	<4.8-48	69
	SPE: Oasis HLB	LC-ESI-MS-MS	2.2-28	70
	SPE: Oasis HLB-MAX	cLC-ESI-MS-MS	<0.12-<0.28	71
	SPE: PS2/AC2, HLB/AC2, PLS-3/AC2	LC-ESI-MS-MS	n.d.	73
	On-line SPE: PLRP-s	LC-ESI-MS-MS	<0.2-4761	74
MTX	SPE: OASIS MCX	LC-ESI-MS-MS	12.6	12
	On-line SPE: Strata-X	LC-ESI-MS-MS	<4-59	24
	SPE: Oasis HLB	UPLC-ESI-MS-MS	4-4689	31
	On-line SPE: Strata-X	LC-ESI-MS-MS	<1-<2	32
	SPE: Oasis HLB	LC-ESI-MS-MS	1.6-18.1	35
	On-line SPE: Strata-X	LC-APPI-MS-MS	Not ionised	37
	On-line SPE: Strata-X	LC-APCI-MS-MS	Not ionised	37
	On-line SPE: Strata-X	LC-ESI-MS-MS	<11	37
	SPE: Oasis HLB	LC-ESI-MS-MS	<0.1	41
	On-line SPE: PLRP-s	LC-ESI-MS-MS	2.1-43.3	51
	SPE: Oasis HLB	UPLC-ESI-MS-MS	23	52
	On-line SPE: Hypersil Gold PFP	LC-ESI-MS-MS	13-60	56
	SPE: Oasis HLB	LC-ESI-MS-MS	7.30-55.8	57
	SPE: Oasis HLB	UPLC-ESI-MS-MS	5-23	60
	On-line SPE: PLRP-s	LC-ESI-MS-MS	2-19.4	61
	SPE: Oasis HLB	UPLC-ESI-MS-MS	<20.24-<29.83	66
	On-line SPE: PLRP-s	LC-ESI-MS-MS	8.3-3920	69
	On-line SPE: PLRP-s	LC-ESI-MS-MS	<0.1-4756	74
	SPE: Oasis HLB	LC-ESI-MS-MS	n.d.-3.5	75
TAM	SPE: Strata X	LC-ESI-MS-MS	<10	7
	SPE: Strata X	LC-ESI-MS-MS	<4-71	9
	SPE: Strata X	LC-ESI-MS-MS	<10-42	10
	SPE: Strata X	LC-ESI-MS-MS	27-740	11
	LLE	GC-EI-MS	1-4	17

	SPE: Oasis HLB	LC-ESI-MS-MS	<0.003	18
	SPE: Strata X	LC-ESI-MS-MS	<0.03	19
	SPE: Oasis HLB	LC-ESI-MS-MS	0.2-1.5	21
	SPE: Oasis HLB	LC-ESI-MS-MS	<1	25
	SPE: Oasis HLB	UPLC-ESI-MS-MS	0.2-8.2	33
	On-line SPE: HySphere Resin GP	LC-ESI-MS-MS	n.d.	34
	SPE: Oasis HLB	LC-ESI-MS-MS	n.d.	36
	SPE: Oasis HLB	UPLC-ESI-MS-MS	<0.05-19.57	40
	On-line SPE: HySphere Resin GP	LC-ESI-MS-MS	n.d.	43
	SPE: Oasis HLB	LC-ESI-MS-MS	0.2-1.8	44
	SPE: Oasis HLB	LC-ESI-MS-MS	<1-<2	45
	On-line TFC	LC-ESI-MS-MS	22.4-22.8	46
	On-line TFC	LC-ESI-MS-MS	12.4-26.8	47
	SPE: Oasis HLB	LC-HESI-MS-MS	13-24	48
	SPE: Oasis HLB	LC-ESI-MS-MS	0.01-115.04	49
	On-line SPE: HySphere Resin GP	LC-ESI-MS-MS	9.25-223	50
	On-line SPE: PLRP-s	LC-ESI-MS-MS	3.5-17.2	51
	SPE: Oasis HLB	UPLC-ESI-MS-MS	26.3-133.4	52
	SPE: Oasis HLB	LC-ESI-MS-MS	8-46	54
	SPE: Strata-X	LC-ESI-MS-MS	3.5-11.7	58
	SPE: Oasis HLB	UPLC-ESI-MS-MS	11-170	60
	On-line SPE: PLRP-s	LC-ESI-MS-MS	102-180.6	61
	SPE: Oasis MAX	LC-ESI-MS-MS	9-76	64
	SPE: Oasis HLB	UPLC-ESI-MS-MS	<3.5-<72.6	66
	On-line SPE: PLRP-s	LC-ESI-MS-MS	7.1-61	69

MCPS	Macroporous Ceramic Passive Sampler
PPL Bond Elut	Priority Polutant Bond Elut
Oasis HLB	Hydrophilic-Lipophilic Balance
Oasis MCX	Mixed-mode, strong Cation-eXchange
Oasis MAX	Mixed-mode, strong Anion-eXchange
XAD-2	Polymer Resin
PLRP-s	Plymeric Reversed Phase
Hypersil Gold PFP	Hypersil Gold Perfluorinated Phenyl
PS2	Styrene-divinylbenzene copolymer
AC2	Activated Carbon
PLS-3	Nitrogen-Containing Methacrylate and SDB copolymer
RP-18	C18 (RP18, ODS, Octadecyl)
C-18	Non-Polar Sorbent (Silica)
HySphere Resin GP	General Phase (polydivinyl-benzene)
Online TFC	Online Turbulent Flow Chromatography
Strata-X	Polymeric SPE Sorbent
LLE	Liquid-liquid extraction

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